# Chapter 3
# Decision Support for Sustainable Supply Chain Management


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## 3.1 Introduction

Sustainability is about managing business decisions in an integrated and balanced manner with regard to economic, social, and environmental dimensions (Elkington 1998). The requirement for sustainability is acknowledged by business stakeholders and is defined as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (WCED 1987).

Supply chains (SC) are crucial for supporting sustainable development due to their wide-ranging impacts and influences. Unsustainable and unaccounted SC impacts are usually not attributable to a single SC partner but are an outcome of all the interactions within the chain. SCs and sustainability requirements alike are characterised by complexities which have to be studied and integrated in practice in order to support sustainable supply chain management (SSCM). Decision makers in SCs are thus tasked with initialising strategic and operational sustainability orientations while maintaining a long-term focus.

However, SSCM suffers from a lack of guidance in the form of decision support models and understanding of relationships between SC actors and their respective activities and enabling/disabling factors. This chapter provides guidance to academics by offering an overview of the field and its development and by helping to focus their research efforts with regard to decision support accordingly. Additionally, it

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provides advice to practitioners on how to structure their SSCM implementation efforts by outlining customised decision support mechanisms.

### *3.1.1 Motivation and Objectives*

Corporate success depends on supply chain management (SCM) (Chen and Paulraj 2004) since significant proportions of revenues are generated through the SC (Lambert and Cooper 2000). Sustainability needs to be integrated into all SC functions in order to have the desired effect (Jayaraman et al. 2007) which is further underlined by pressures from regulations, customers, reputation, competition, and the public (Esty and Winston 2006; Lieb and Lieb 2010; Linton et al. 2007). However, economic priorities often override these requirements despite the fact that SSCM is also demanded from an economic point of view, due to for example globalisation effects, dependencies on foreign markets and imports, outsourcing, SC disruptions, or economic recessions (Lee 2010). The economic, political, social, and ethical pressures of Corporate Social Responsibility (CSR) (Garriga and Melé 2004) further motivate SSCM.

From an academic research perspective, sustainability continues to be a popular topic and the field of SSCM has grown and matured considerably (see e.g. Carter and Washispack 2018; Reefke and Sundaram 2017; Seuring and Müller 2008b; Winter and Knemeyer 2013). During this growth SSCM has been influenced by related fields including SCM, logistics, operations management, environmental management, social sciences, marketing, and strategy (Badurdeen et al. 2009; Carter and Rogers 2008). Despite these advances, fully acknowledged theories of SSCM are absent and have not been implemented in SC practice. Further targeted SSCM research is recommended in order to identify and exploit the multifaceted sustainability opportunities in SCs (Carter and Easton 2011; Colicchia et al. 2011; Dey et al. 2011; Halldórsson and Kovács 2010; Pagell and Wu 2009; Reefke and Sundaram 2017; Winter and Knemeyer 2013).

Practical implementation continues to be difficult but research has started to investigate the requirements and practices to support SSCM (Reefke and Sundaram 2017; Wagner and Svensson 2010). SC practitioners are in need of guidance in the form of decision support mechanisms in order to advance the application of sustainable SC strategies and operations. Scholars in the field have outlined the need for a solid understanding of SSCM relationships and validated decision support models (Reefke and Sundaram 2017, 2018) which would also ensure the relevance of research efforts. This chapter is intended to provide guidance to scholars in the field by addressing the following key objectives:

- Provide a synthesis of definitions and characteristics of SSCM.
- Identify research requirements regarding decision support for SSCM.
- Investigate processes that can support decisions that will ultimately transform SCs towards SSCM.

- Outline targeted decision support models in order to aid transformation and ongoing development of SSCM.

### *3.1.2 Article Structure*

Following the outline of the research motivation and objectives for this study, the article progresses with an overview of definitions of SSCM and illustrates key characteristics of sustainable SCs. It then synthesises research recommendations from a selection of seminal articles in the field with regard to decision support in SSCM. This is followed by an account of decision models specifically targeted at outlining theoretical connections in SSCM and at providing decision support to SC practitioners. The models are further elaborated within a case context in order to illustrate their usefulness. Concluding comments reflect on how these findings contribute to the understanding of SSCM and how they can be leveraged by SC scholars.

## 3.2 Sustainable Supply Chain Management

This section is organised into three interconnected parts. First, the progression of SSCM as a research field is explained and a selection of academic definitions of SSCM is presented. Second, sustainability considerations are elaborated on. Third, the key characteristics of sustainable supply chains are outlined.

### *3.2.1 Defining Sustainable Supply Chain Management*

SSCM is an area that has evolved through insights from various related fields of business research and has become an established area of academic enquiry. The growing array of structured reviews of literature on SSCM (see e.g. Carter and Washispack (2018) for a synthesis of 59 structured literature reviews) are evidence for the rapid progression of the field. Many definitions of SSCM have emerged especially in the early years of academic discourse but there is no generally acknowledged definition (Ashby et al. 2012). This may be due to the multidisciplinary nature in adding sustainability to SCM, which itself originated from fields such as purchasing, logistics, and transportation (Croom et al. 2000). Table 3.1 provides an overview of SSCM definitions proposed over the years and numbered in chronological order of publication.

From these definitions it is evident that SSCM deals with the coordination of all SC flows while the requirements of all relevant stakeholders should be met and optimised in accordance with the three sustainability dimensions. The need for an integrated and holistic focus on the triple bottom line (environmental, economic,

**Table 3.1** Definitions of SSCM

| Source | SSCM definition |
|---|---|
| Carter and Rogers (2008: 368) | SSCM is the strategic, transparent integration and achievement of an organization's social, environmental, and economic goals in the systemic coordination of key inter-organizational business processes for improving the long-term economic performance of the individual company and its SCs |
| Seuring and Müller (2008b: 1700) | SSCM is the management of material, information and capital flows as well as cooperation among companies along the SC while taking goals from all three dimensions of sustainable development, i.e. economic, environmental and social, into account, which are derived from customer and stakeholder requirements. In sustainable SCs, environmental and social criteria need to be fulfilled by the members to remain within the SC, while it is expected that competitiveness would be maintained through meeting customer needs and related economic criteria |
| Pagell and Wu (2009: 38) | A truly sustainable SC would at worst do no net harm to natural or social systems while still producing a profit over an extended period of time; a truly sustainable supply chain could, customers willing, continue to do business forever<br>A sustainable SC is one that performs well on both traditional measures of profit and loss as well as on an expanded conceptualization of performance that includes social and natural dimensions. SSCM is then the specific managerial actions that are taken to make the SC more sustainable with an end goal of creating a truly sustainable chain |
| Baburdeen et al. (2009: 57) | SSCM involves the planning and management of sourcing, procurement, conversion and logistics activities involved during pre-manufacturing, manufacturing, use and post-use stages in the product lifecycle in closed-loop through multiple lifecycles with seamless information sharing about all product lifecycle stages between companies by explicitly considering the social and environmental implications to achieve a shared vision |
| Hassini et al. (2012: 70–71) | SSCM is the management of SC operations, resources, information, and funds in order to maximize the SC profitability while at the same time minimizing the environmental impacts and maximizing the social well-being. Objectives: while maximizing profits calls for reducing operations costs, minimizing the environmental impacts and maximizing the social well-being can add to the SC's operational costs. Challenges to SC managers: dealing with multiple decision makers and assessing the environmental impacts and social benefits in a multi-party SC |
| Ahi and Searcy (2013: 339) | The creation of coordinated SCs through the voluntary integration of economic, environmental, and social considerations with key inter-organizational business systems designed to efficiently and effectively manage the material, information, and capital flows associated with the procurement, production, and distribution of products or services in order to meet stakeholder requirements and improve the profitability, competitiveness, and resilience of the organization over the short- and long-term |
| Pagell and Shevchenko (2014: 45) | SSCM is the designing, organizing, coordinating, and controlling of SCs to become truly sustainable with the minimum expectation of a truly sustainable SC being to maintain economic viability, while doing no harm to social or environmental systems |

and social) is pointed out frequently but many publications tend to focus on a single or two dimensions. Especially investigations into social considerations are lacking but are urgently needed in order to understand the many trade-offs in SSCM decision-making (Cruz 2009; Seuring 2013). Several academic scholars in SSCM have voiced significant critique of the prevalent triple bottom line thinking that is based on a balance of the three sustainability dimensions. A prioritisation of environmental and social considerations over economic demands is suggested as the way to achieve SC sustainability (see e.g. Markman and Krause 2016; Montabon et al. 2016).

### *3.2.2 Sustainability Considerations*

SSCM has been described as an extension of green SCM with an additional focus on economic and social considerations (Ahi and Searcy 2013; Ashby et al. 2012; Sarkis 2012). Sustainability is often seen as synonymous with the triple-bottom-line (TBL) which focusses on social, environmental, and economic goals (Ahi and Searcy 2013; Seuring 2013; Winter and Knemeyer 2013). SSCM aims for the alignment of a SC in order to satisfy TBL considerations as well as concerns of SC stakeholders (Carter and Rogers 2008; Seuring and Müller 2008b). The TBL assigns equal importance to the three sustainability dimensions (Montabon et al. 2016) and has had a dominant influence on sustainability related research. Influenced by TBL thinking, SSCM has an extended focus towards improving the long-term economic performance of the SC as a whole and its individual firms while applying environmental-friendly strategies and taking social responsibilities into account (Carter and Rogers 2008; Svensson 2007). Both, inter- and intra-organisational connections need to be considered in order to support the collaborative development of SC sustainability. This integrative view of the TBL aligns with stakeholder theory, that is, capturing all SC impacts and the effects on its stakeholders (Montabon et al. 2016). The value of the TBL to achieve true sustainability in SCs has however also been questioned since the concept aims for win-win relationships and may not support trade-offs that are detrimental to a single dimension (Markman and Krause 2016; Montabon et al. 2016).

#### 3.2.2.1 Economic Considerations

Although supposedly of equal importance, the majority of companies will firstly focus on their economic viability (Markman and Krause 2016; Montabon et al. 2016). SSCM can help companies to portray themselves as environmentally friendly and can lead to marketing advantages (Smith et al. 2010). However, a lack of profit would likely result in the termination or reduction of practices associated exclusively with environmental or social benefits. Hassini et al. (2012) acknowledge the difficulty of achieving multiple TBL goals and regard SC profitability as vital while

environmental and social impacts should be managed to one's best abilities. They put emphasis on the reduction of operational costs in order to maximise profits and point towards potential trade-offs between the profitability of a SC as a whole and that of individual companies. Seuring and Müller (2008b) and Font et al. (2008) draw attention to the need to focus on customer requirements, that is, that competitiveness is contingent on satisfying the needs of their customers by employing market focussed resources and meeting economic performance criteria.

Researchers have identified several economic motivators for SSCM, including potential increases in shareholder value, customer demand, market share, employee retention, business opportunities, innovation, reputation, as well as risk reductions (Esty and Winston 2006; Seuring and Müller 2008b). Other economically relevant attributes include improved SC relationships, increased levels of collaboration and information sharing, reduction of opportunistic behavior, and the development of sustainability characteristics which are difficult to replicate (Carter and Rogers 2008; Kleindorfer et al. 2005). Based on the economic considerations mentioned, connections can thus be drawn between applying SSCM, the development of unique SC and company specific attributes, and higher profitability coupled with competitive advantages.

#### 3.2.2.2 Environmental Considerations

The term "sustainability" still carries different meanings and it is frequently associated with economic and environmental dimensions only (Montabon et al. 2016; Sarkis 2012). Sustainability initiatives, and the introduction of sustainability into SCs, started with environmental considerations and also researchers have predominantly focussed on assessing the resulting economic implications (Ahi and Searcy 2013; Ashby et al. 2012; Berger et al. 2001; Font et al. 2008). This focus has become known as "green SCM" and is concerned with environmental innovations, product life cycle considerations, and the selection of members for the SC based on environmental practices and strategies (Berger et al. 2001; Srivastava 2007). Such an environmental SC focus has been pushed forward by various factors including regulations, customer perceptions, risk management, efficiency gains, and cost.

Generally SCs should reduce environmental impacts and impose no harm on the environment. The reduction of waste material and especially hazardous waste is crucial (Linton et al. 2007; Nunen et al. 2005). This should be coupled with more efficient usage of natural resources, materials, and energy (Nunen et al. 2005). Unintended by-products from manufacturing, product usage, and disposal need to be avoided which likely requires the inclusion of sustainability considerations into product design, the forward SC and reverse logistics in order to manage product recovery processes. Environmental performance of a SC is thus directly connected to the design and lifecycle of a product, which determine whether production and usage follow environmental considerations and whether resources can be effectively recovered at the end of a product's life (Badurdeen et al. 2009; Linton et al. 2007).

#### 3.2.2.3 Social Considerations

The inclusion of social aspects into sustainable operations and SC research is less explored (Carbone et al. 2012; Sarkis 2012; Seuring 2013; Walker et al. 2014). Social measures are harder to quantify than economic and environmental aspects (Goldschmidt et al. 2013) and environmental issues often supersede social considerations in shaping organisational sustainability (Carbone et al. 2012). Some researchers see only few synergies between these dimensions at corporate and SC levels, requiring the development of distinct capabilities for improvement in either dimension (Carbone et al. 2012). However, social and environmental dimensions have also been described as co-dependent (Orlitzky et al. 2003) with predominantly win-win relationships (Seuring and Müller 2008a).

Social sustainability is linked to CSR, which is driven by ethical values and codes of conduct in order to balance the interests of corporate stakeholders (Ashby et al. 2012). Increasing employee motivation is driving CSR since employees generally prefer to work for "responsible" companies. Focussing on corporate sustainability is positively correlated with financial performance, mainly due to reputation gains (Orlitzky et al. 2003) but it is not certain if this relationship applies in SCs to the same extent (Seuring and Müller 2008a). Other potential benefits triggered by a social SC orientation include employee health and safety, fair treatment and social equity, fostering employee skills and abilities, and adding human capital to society (Ashby et al. 2012).

Hassini et al. (2012) point out that social well-being can increase operational costs. Especially low-cost producers are likely to neglect social considerations in their SCs which often operate in socially sensitive industries (Hoejmose et al. 2013). CSR is also not equivalent with true sustainability since companies and SCs can engage in socially praiseworthy actions without addressing the root causes of their unsustainable behavior (Markman and Krause 2016). A social SC focus ultimately requires an extension beyond organisational and SC considerations towards improving quality of life and equity in the communities affected by the SC operations (Vachon and Mao 2008).

### *3.2.3 Sustainable Supply Chain Characteristics*

#### 3.2.3.1 Sustainable Supply Chain Focus

Significant proportions of business revenues are generated through SCs which are frequently networks of globally dispersed companies faced with different regulatory restrictions, market conditions, and customer requirements (Cooper et al. 1997; Lambert and Cooper 2000). SC strategies are often based on the availability of cheap transport (Halldórsson and Kovács 2010) as well as production costs, quality, delivery terms, and flexibility considerations. SCs often rely on global sourcing and neglect energy efficiencies in order to save on labour or storage costs (Halldórsson

and Kovács 2010). The resulting global networks do not necessarily lend themselves to quick operational shifts or strategic reorientations due to their complexity, dependence on infrastructure, economic importance, and the predominately cost based sourcing considerations. Further, SCs are often characterised by only limited visibility and control between individual companies. There are various systemic interactions that decision makers need to take into consideration when making changes to a SC (Mentzer et al. 2001). The introduction of sustainability principles is challenging in any organisational environment but associated difficulties naturally increase with the number of companies and stakeholders involved. Tackling sustainability challenges requires a holistic SC response (Carter and Easton 2011) and sustainability considerations need to be integral to SC decisions in order to address the wide-reaching impacts of business conduct (Jayaraman et al. 2007; Kleindorfer et al. 2005). Linton et al. (2007) even describe SCs as a catalyst for the broader adoption of sustainability. With this shift in focus, the sustainability debate needs to evolve as well towards a strategic focus on SSCM (Carter and Rogers 2008; Jayaraman et al. 2007; Seuring and Müller 2008b). Decision makers in SCs find themselves in a crucial position (Sarkis 1998) since their decisions have significant negative as well as positive sustainability impacts (Carter and Easton 2011; Murphy and Poist 2003). Svensson (2007) adds that decision makers need to take into account their connections across multiple SCs, which requires visibility of all interfaces.

#### 3.2.3.2 Building Blocks for a Sustainable Supply Chain

In order to foster SSCM, Carter and Rogers (2008) emphasise the need to focus on systemic relationships between inter-organisational business processes in order to integrate and achieve holistic sustainability goals. Other authors reflect especially on the dynamics between multiple decision makers across the SC members (Hassini et al. 2012). Challenges are likely to arise when assessing and quantifying sustainability impacts and benefits that a SC causes. In turn, decisions regarding potential countermeasures, monetary investments, resource allocations, or the equal distribution of potential benefits pose challenges. Individual members in a SC may try to gain benefits while avoiding necessary investments, that is, members may aim for local optimisation instead of a collaborative sustainability effort (Carter and Rogers 2008; Shepherd and Günter 2006).

According to Christopher (1998) SCM relies "on cooperation and trust and the recognition that properly managed the whole can be greater than the sum of its parts". Mentzer et al. (2001) emphasise that a true SC orientation is characterised by the visibility of tactical implementations and SC strategy across the chain. Applying these insights, a building block for SSCM is a shared or common vision which is a key component for any SC transformation (Tan et al. 1998) and has been described as essential for success in SCM (Mentzer et al. 2001). In another step towards SSCM, Seuring and Müller (2008b) suggest that SC wide sustainability goals should be based on a balanced review of all SC stakeholder requirements, while

competitiveness is simultaneously ensured by meeting customer needs. When determining sustainability goals, the need for a full SC perspective is generally emphasised that encompasses all SC activities such as procurement, production, distribution, pre-manufacturing, manufacturing, use, and post-use stages (Ahi and Searcy 2013; Badurdeen et al. 2009). Visibility and control of the various SC flows have to be maintained and fostered, including capital flows, information and decision flows, logistics and material flows, as well as product and service flows (Ahi and Searcy 2013; Hassini et al. 2012; Seuring and Müller 2008a). Hence, the integration of inter-organisational business systems (Ahi and Searcy 2013) as well as seamless information sharing (Badurdeen et al. 2009) are described as essential. Following this argument, Carter and Rogers (2008) identify transparency as a key component of SSCM based on active stakeholder engagement and visibility of supplier operations. Horizontal and vertical SC collaboration and strategic relationships have been associated with success in sustainability initiatives and competitive advantage (Harris et al. 2010; Lee 2008). They can improve relations and aid in developing trust and long-term relationships between suppliers, that is, characteristics which are not easily duplicated by competitors (Carter and Rogers 2008). In terms of environmental improvements, close SC relationships can lead to the elimination of waste through quality management, as well as coordinated pollution reduction, control, and prevention (Bansal and McKnight 2009). Lastly, SC practitioners should be more proactive about communicating their SSCM efforts as well as concerns in order to further develop their reputation, increase SC coordination, and lower costs (Carter and Rogers 2008; Krause et al. 2009).

## 3.3 Research Requirements on Decision Support

The field of SSCM has expanded quickly and authors have outlined research directions respectively. In order to provide an informed overview of research requirements on decision support for SSCM, we summarised research recommendations from literature that investigate the field from different angles. Reefke and Sundaram (2017) utilised a Delphi approach in order to extract research suggestions from domain experts. Seuring (2013) explored the application of modelling approaches whereas Winter and Knemeyer (2013) targeted their article specifically at suggesting avenues of research. Ashby et al. (2012) performed a structured review with a focus on social and environmental aspects while Hassini et al. (2012) focussed on performance aspects. Carter and Easton (2011) finally derive future research directions from a selection of SC journals.

It is evident from the research requirements in Table 3.2 that decision support is yet to be developed in support of the various aspects of SSCM. Despite the fact that the field has seen many useful contributions over the years, practical decision support and prescriptive methods or tools are largely absent. The recommendations include the investigation of biases and trade-off decisions (Carter and Easton 2011), as well as a focus on cost allocations and unaccounted SC impacts (Reefke and

**Table 3.2** The need for decision support in SSCM (adapted from Reefke and Sundaram 2017)

| Source | Decision support—research requirements |
|---|---|
| Reefke and Sundaram (2017) | • Actual costs of supply chain operations, for example unaccounted environmental and social impacts |
| | • Future of supply chains, for example long-term outlook and restructuring needs |
| | • Investments into sustainability and their justifications |
| | • Implementation hurdles of sustainability initiatives, for example time and cost requirements |
| | • Long supply chains and resulting special requirements |
| | • Transportation modes, for example which mode works best for each commodity |
| | • Cost allocations, for example for sustainability efforts and unaccounted supply chain impacts |
| | • Missing theory development to guide practice, for example lack of strategic models and applicable frameworks |
| Seuring (2013) | • How can the social dimension be integrated into respective models? |
| | • Interrelation among all three dimensions of sustainability and models thereof |
| | • How does environmental and social performance impact supply chain performance? |
| | • Establish the links to the literature on strategic supply chain design, supply chain performance and collaboration |
| Winter and Knemeyer (2013) | • Research should look at the connection between managerial components and sustainability efforts, in an effort to better understand how managerial practices can influence the success or failure of sustainability initiatives |
| | • Companies need specific guidelines and an explicit toolbox that supports their efforts to reach their sustainability objectives, for example structural management components and adequate control mechanisms |
| | • The development and validation of appropriate metrics and scorecards in support of SSCM |
| | • The development of estimation tools and techniques to provide financial justifications |
| | • Investigate how suppliers can engage their customers on sustainability initiatives or to better understand how sustainable supply chain initiatives can be used to enhance a company's brand and/or marketing efforts |
| Ashby et al. (2012) | • The role of supply chain relationships in achieving sustainability |
| | • Life cycle analysis and the concept of closed loop supply chains could provide a more connected view of sustainability in supply chains |
| | • An integrated, holistic, and relational viewpoint is vital for progressing SSCM from "greening" to a "virtuous circle" that addresses sustainability interactions as well at all stages |
| | • Translating SSCM theory developed through more focussed approaches into actual supply chain practice should be a key priority |

(continued)

**Table 3.2** (continued)

| Source | Decision support—research requirements |
|---|---|
| Hassini et al. (2012) | • Pricing, as part of the value proposition to the customer, should be more strongly emphasised |
| | • Address inventory management within sustainable supply chains since traditional inventory models focus on economic aspects |
| | • How should SMEs and large firms approach investment in and adoption of sustainable practices? |
| | • Research into performance assessments of sustainable supply chain, for example metrics, composite indicators, compatibility with existing theory |
| Carter and Easton (2011) | • Research to dig deeper into individual industries as sampling frames to identify specific types of sustainability activities and assess the applicability of specific theories |
| | • Investigate the relationship between company environmental and social performance versus economic performance |
| | • Examine how bounded rationality and perceptions of opportunism within the context of SSCM impact the decision to source domestically or even locally, as opposed to internationally, and how supply chain governance structures are affected |
| | • Examination of the biases that can enter the individual decision-making process, and how these biases can impact the efficacy of SSCM initiatives |
| | • Investigation of how individual managers can influence and gain the commitment of key internal stakeholders to bring SSCM projects to fruition |

Sundaram 2017). Prominent decision areas in need of support furthermore include the various facets of risk management (Hassini et al. 2012; Winter and Knemeyer 2013). More targeted decision support extends to the development of performance management tools such as indicators, metrics, and scorecards (Hassini et al. 2012; Winter and Knemeyer 2013). Developing an understanding of human resources in support of SSCM are called for by investigating managerial components and practices (Winter and Knemeyer 2013) as well as extended supply chain relationships and the role of individual decision makers (Carter and Easton 2011).

It can be summarised that the field is lacking practical insights and advice on how to implement and progress a strategic orientation towards sustainability supported by sustainable supply chain operations (see e.g. Ashby et al. 2012; Carter and Easton 2011; Hassini et al. 2012; Reefke and Sundaram 2017; Seuring and Müller 2008b; Winter and Knemeyer 2013). SC managers need guidelines and prescriptive support in order to guide long term SC planning and daily operations. Thus, decision-making tools need to be able to deal with this multifaceted nature of SSCM, the many systemic interconnections between SC actors, and the trade-offs involved in decision-making processes. The following sections outline several models targeted at providing such support mechanisms.

## 3.4 Decision Models

This section introduces two models that have been developed particularly for addressing the need for practical decision support in SSCM. These models are the outcome of a rigorous research study (Reefke and Sundaram 2018) and may prove to be instrumental for the understanding of SSCM relationships and SSCM application. Both models are based on seminal management approaches aimed at (1) transforming SC towards SSCM and (2) developing SSCM towards higher levels of maturity.

### *3.4.1 SSCM Transformation*

Decision makers in SCs are tasked with introducing sustainability principles into their daily tasks and operations. Such shifts in operating principles take time to plan, implement, and control. Hence, procedural support is required that provides guidance in this endeavour. The SSCM transformation model put forward in this section builds on existing transformation approaches and adopts high level transformation steps. However, it is then customised for SSCM through the definition of requirements and support mechanisms for each step.

#### 3.4.1.1 Models of Transformation

The ability to adapt and transform to changing requirements is vital for successful businesses and SCs (Beamon 1999; Lee 2004). The ability to transform and continuously improve SC processes from strategic and operational perspectives are thus also central for sustainable development. A selection of relevant transformation approaches is therefore introduced here and their underlying structures are synthesised in Table 3.3.

A variety of transformation models can be found in literature, both generic as well as specialised. Transformation models have a practical orientation by nature but are frequently lacking comprehensive academic evaluations regarding for example ease of implementation, speed of transformation, and the retention of success. In support of the approach put forward for SSCM, several useful scholarly evaluations of transformation models outlining their positive characteristics alongside their limitations can be pointed out. Furthermore, such models are commonplace in management consulting and have been successfully applied throughout various industries (see e.g. de Mast and Lokkerbol 2012; Schroeder et al. 2008). The transformation approaches shown are based on foundational decision-making models such as Simon (1977), Mintzberg et al. (1976), Hage (1980), and Langley et al. (1995).

It is apparent from the synthesis provided in Table 3.3 that the transformation models reviewed share common elements, phases, and structures. They generally

**Table 3.3** Synthesis of transformation models

| Authors | Objectives | Phases/steps/levels |
|---|---|---|
| Deming (1986) | PDCA—Continuous process improvement | (1) Plan, (2) Do, (3) Check, and (4) Act |
| Heskett et al. (1994) | Service profit chain—Increase service quality and profitability | (1) Internal service quality, (2) Employee satisfaction, (3) Employee retention/productivity, (4) External service value, (5) Customer satisfaction, (6) Customer loyalty, and (7) Revenue growth/profitability |
| Scheer et al. (2003) | ARIS—Enterprise modelling and business process management | (1) Strategise, (2) Design, (3) Implement, and (4) Control |
| Gilmour et al. (2004) | IBM Consulting—Value creation and growth cycle | (1) Increase sales and market share, (2) Earn more margin, (3) Reinvest in processes and technology, (4) Drive greater productivity, (5) Invest in differentiators, and (6) Deliver greater value to customers |
| Schroeder et al. (2008) | DMAIC—Process analysis and control | (1) Define, (2) Measure, (3) Analyse, (4) Improve, and (5) Control |
| The Natural Step (2009) | The Natural Step—Sustainability implementation | (1) System, (2) Success, (3) Strategic, (4) Actions, and (5) Tools |

start with an exploratory discovery/learning phase, followed by a planning/designing phase with a subsequent implementation/monitoring/control phase. Most approaches emphasise targeted, key performance indicator (KPI) driven analysis and continuous performance control in order to prevent shifting back to previous patterns. Realising the potential benefits requires that sustainable processes become institutionalised as routines in the organisation (Schroeder et al. 2008) which would need to be adapted and extended across the SC. Due to the wide spread usage and acceptance of structured transformation approaches, it is rational to leverage the underlying structures as a basis for SC transformations towards sustainability. A targeted decision support model in this regard is introduced next.

#### 3.4.1.2 SSCM Transformation Model

The high level SSCM transformation model, shown in Fig. 3.1, is influenced and informed by the transformation approaches outlined in Table 3.3. The bottom-up development of its detailed elements makes it unique to SSCM, as further elaborated in Reefke and Sundaram (2018).

Transformation approaches frequently start with "discovering" and "learning" in order to guide process and, if applicable, sustainability transformations. Discovery is about the evaluation of external and internal sustainability requirements, while learning is about assessing internal capabilities and support mechanisms. "Strategising" deals with the development of an SSCM strategy and respective SC processes. Other transformation approaches include similar steps (e.g. Scheer et al. 2003; The Natural Step 2009) since strategic decisions have long-term implications

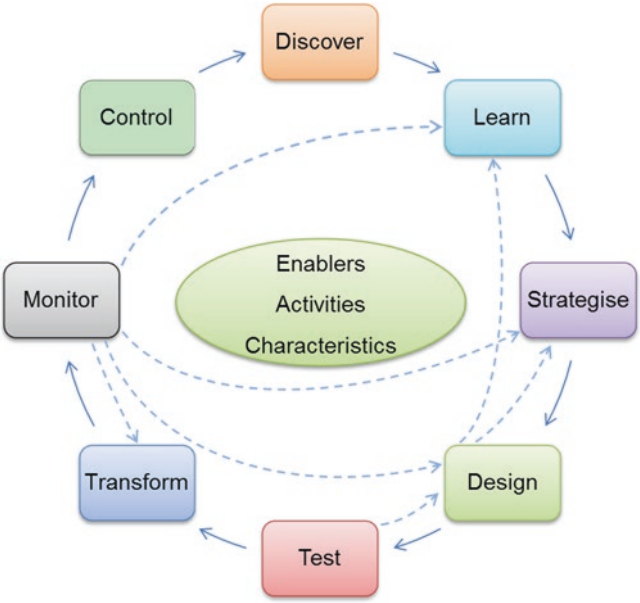


**Fig. 3.1** SSCM transformation model (adapted from Reefke and Sundaram 2018)

for all SC stakeholders. In this step it is recommended to define transformation goals and balance resulting trade-offs accordingly. The "design" phase translates the strategy into implementable activities and methodical procedures first. This is followed by "testing", offering validation before the actual implementation takes place. Unfavourable test results are accounted for through feedback loops linking to previous steps so that remedial actions can be taken and implemented into preceding steps. The final design can then be implemented through the transformation phase which puts the strategy into action. "Monitor" facilitates an assessment regarding the success of the transformation in order to inform SC stakeholders accordingly. Feedback loops again ensure that issues can be addressed from the most appropriate phase. The "control" phase finally focusses on the success of individual process transformations and the transformation towards the end goal of becoming a sustainable SC as a whole. Accordingly, full and partial cycles are recommended in order to support sustainability improvements at process and strategic levels.

The SSCM transformation model is designed to provide targeted decision support and also serves the purpose of managing sustainability risks at strategical and operational levels. The SSCM transformation model puts forward a selection of cyclical steps, activities, and requirements. The model elements are informed by following a top-down approach for establishing the high level structure and a bottom-up approach for customising it towards the specific application of SSCM. As elaborated in Reefke and Sundaram (2018), a ranking proposes that certain elements are particularly supportive, or even essential, for each step. While no model

or framework can be truly comprehensive, it offers a wide-ranging overview that can guide transformation efforts by supporting prioritisation and resource allocation. The intention is to establish a common methodology across SCs in order to guide transformation efforts, align sustainability goals, and enable continuous improvements through its cyclical nature. This SSCM decision model may thus be instrumental for implementing a sustainable SC strategy and the resulting transformation of underlying structures, processes, and systems. Furthermore, it can be the starting point for establishing a SC-wide sustainability culture.

The succeeding sections establish processes on how these outcomes can be developed or matured further.

### *3.4.2 SSCM Maturity*

The SSCM maturity model introduced in this section puts forward the notion that SCs exhibit different levels of maturity with regard to their sustainability integration and application. It is informed by the high-level structures of existing maturity models and, as with the SSCM transformation model, introduces customised building blocks that are unique to SSCM. The idea that higher levels of SSCM proficiency can be reached over time and fostered through the application of targeted developments underlies this model. As such, the SSCM maturity model is meant to be utilised as a decision support tool in order to make existing SCs more sustainable but is also intended to guide the development of truly sustainable SCs.

#### 3.4.2.1 Overview of Maturity Models

Maturity models are designed to aid businesses in creating an overview of their own processes. They establish a structured approach based on a common vision and language. Furthermore, the maturity concept allows for the prioritisation of goals and activities and guides respective performance management and benchmarking activities (Carnegie Mellon—Software Engineering Institute 2002; Lockamy and McCormack 2004; McCormack 2001). The maturity concept assumes that business characteristics can be categorised into levels of development describing associated behavioural, regulative, and performance standards. A maturity level can be described as an evolutionary plateau of process improvement (Carnegie Mellon—Software Engineering Institute 2002) which is further based on the assumption that processes can be organised into stages of development (McCormack et al. 2008). Such staggered developmental stages are often central to successful SC initiatives, transformations, and a long-term development strategy (Stevens 1993). Maturity models generally encompass elements that relate to definition, measurement, management, and business process control. Scholars associate higher maturity with better managerial control, improved forecasting, lower costs, effective goal attainment,

and successful continuous improvement methodologies (Lockamy and McCormack 2004; McCormack et al. 2008).

In summary, maturity development represents a logical approach to progression, especially in bigger systems like SCs, since process changes and improvements are best implemented successively (Carnegie Mellon—Software Engineering Institute 2002; Lockamy and McCormack 2004). Table 3.4 synthesises the objectives, aims, and model structures of selected maturity models, i.e. the definition of levels according to distinct developmental stages. While aimed at describing different parts of business or SC developments, similarities between the level descriptions are evident. Furthermore, developmental goals and requirements are generally defined for each level in order to guide decision makers in their efforts and in the allocation of resources.

#### 3.4.2.2 SSCM Maturity Model

Companies and SCs generally aim to continuously improve, or mature, their processes, structures, policies, and capabilities in order to increase competitiveness. As illustrated in the previous section, maturity models define distinct levels of development and offer a structured approach for improvement. The maturity concept is well established in literature and scholars accept the notion that maturity models can guide managerial decision makers (Carnegie Mellon—Software Engineering Institute 2002; Lockamy and McCormack 2004). Thus, it is advisable to adopt the general structural elements and logic of established seminal work but to adapt these aspects according to the purpose at hand. Accepting this approach, a maturity model for SSCM should provide and detail the following aspects:

- outline the purpose of the transformation,
- provide a common language by setting goals, objectives and guidelines,
- determine responsibilities,
- establish a clear direction and shared vision,
- help users to communicate and evaluate their decisions,
- outline a progression strategy between the current state and the long-term strategy.

Based on these requirements, an SSCM maturity model was developed as shown in Fig. 3.2. Associated descriptions of each level alongside specific goals and requirements can be seen in Table 3.5. The top level structure has been informed by the maturity models reviewed and summarised in Table 3.4. Their insights and essential building blocks were leveraged towards a design targeted at SSCM. The proposed maturity progression is organised in six levels ranging from “un-aware and non-compliant” at the lowest level (1) towards “extended and sustainability leadership” (level 6). As shown in Table 3.5, the levels correspond to specific stages of SSCM maturity and provide directions and a vision for further development. Goals and requirements are identified at each level, thereby establishing an overall SSCM vision as well as a development strategy. The model maintains a neutral,

**Table 3.4** Synthesis of maturity models

| Authors | Objectives | Levels |
|---|---|---|
| Stevens (1993) | SC integration | 1—Baseline<br>2—Functional integration<br>3—Internal integration<br>4—External integration |
| Starik and Rands (1995) | Sustainability levels and systems | 1—Individual<br>2—Organisational<br>3—Political-economic<br>4—Social-cultural<br>5—Ecological |
| Beamon (1999) | Environmental management in SCs | 1—Problem solving<br>2—Managing for compliance<br>3—Managing for assurance<br>4—Managing for eco-efficiency<br>5—Fully integrated |
| Veleva and Ellenbecker (2001) | Sustainability performance indicators | 1—Facility compliance/conformance<br>2—Facility material use and performance<br>3—Facility effect<br>4—SC and product life cycle<br>5—Sustainable systems |
| Carnegie Mellon—Software Engineering Institute (2002) | Process maturity | 1—Ad hoc/individual competencies<br>2—Increased visibility<br>3—Standardised processes<br>4—Performance management<br>5—Continuous improvement |
| Yusuf et al. (2004) | SC agility | Three maturity stages of SC agility for the intertwined customer interaction, asset configuration, and knowledge leverage dimensions |
| Lockamy and McCormack (2004) | SCM and process maturity | 1—Ad hoc and undefined<br>2—Defined<br>3—Linked<br>4—Integrated<br>5—Extended |
| Marshall and Toffel (2005) | Sustainability requirements | 1—Endanger human life<br>2—Reduce life expectancy<br>3—Species extinction and human rights violation<br>4—Subjective values of the quality of life |
| OMG (2008) | BPMM—Process maturity | 1—Initial<br>2—Managed<br>3—Standardised<br>4—Predictable<br>5—Innovating |
| Boone et al. (2009) | GAIA—SSCM maturity | 1—Genesis: Compliance focus<br>2—Advancing: Develop strategic objectives<br>3—Innovating: Coordinated strategy<br>4—Accelerating: Vision, goals and proactive behaviour |

(continued)

**Table 3.4** (continued)

| Authors | Objectives | Levels |
|---|---|---|
| GCIO and OMG (2009) | Green business maturity | 1—Ad hoc<br>2—Common understanding<br>3—Governance structure<br>4—Internal optimisation and extension<br>5—Economic returns from green initiatives |

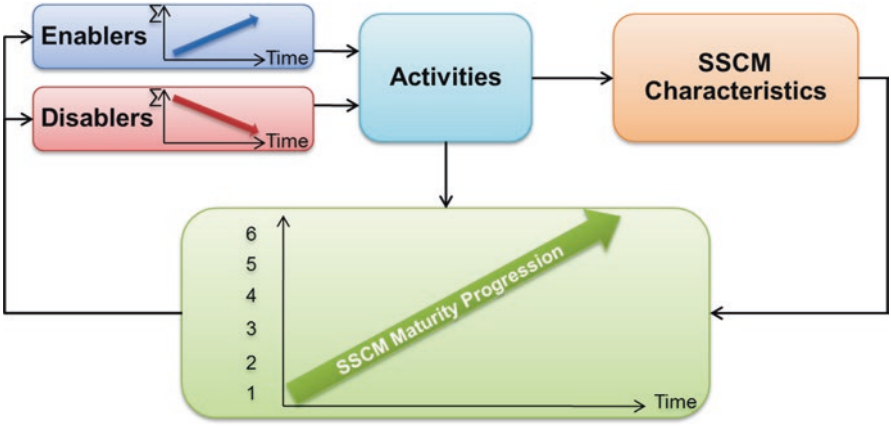


**Fig. 3.2** SSCM maturity model (adapted from Reefke and Sundaram 2018)

**Table 3.5** SSCM maturity levels (Reefke and Sundaram 2018)

| Level | Description | Goals and requirements |
|---|---|---|
| **6** | Processes are systematically managed through continuous improvement. Full SC collaboration embracing sustainability leadership position | *Continue* to optimise processes and ensure future leadership position |
| **5** | Sustainability has become a fully integrated concept and SC has moved towards proactive measures | *Propagate* strategic concepts and move towards leadership position |
| **4** | SC is linked and includes a comprehensive sustainability performance measurement system | *Develop* from compliance level towards proactive sustainability efforts |
| **3** | Sustainability goals/standards have been defined and SC members are compliant with regulations | *Establish* key indices to measure sustainability performance within SC |
| **2** | Sustainability measures are disconnected from strategic direction. Compliance on a basic level | *Align* sustainability goals and efforts with defined processes. Establish consistency |
| **1** | SC is unaware and non-compliant to any regulations and undertakes no sustainability efforts | *Create* sustainability awareness. Introduce sustainability initiatives |

generalisable approach in order to remain customisable towards specific SC requirements and decision challenges.

The SSCM maturity model, shown in Fig. 3.2, maps the dynamic relationships between maturity and SSCM factors. The logic of the decision model can be summarised as follows:

> *The existence of certain enabling factors helps a SC to perform activities that support SSCM, whereas disablers prevent a SC from doing so. In combination these result in certain characteristics that the SC possesses. As a SC develops such characteristics, it reaches higher levels of maturity. Along with higher maturity levels the amount of disabling factors and/or their effects decrease and the amount of enabling factors and/or their effects increase, which allow for more activities directed at sustainability in SCs.*

Reefke and Sundaram (2018) identified a total of 96 SSCM factors which are further separated into 26 enablers, 21 disabler, 23 activities, and 26 characteristics. As shown in Fig. 3.2, the factors are logically interconnected and were furthermore evaluated with regard to their comparative importance. The relationships put forward by this decision model can be illustrated through a selection of SSCM factors relating to performance measurement. The activity "definition and measurement of clear key performance indicators" may only be feasibly performed if "performance measurement tools for consistent and accurate measurement" (enabler) exist. On the flipside, it can be hindered by disabling factors such as a "focus on short term financial performance" or a "misguided focus in the sustainability movement" which may potentially lead to performance targets that are not reflective of a balanced sustainability orientation. Accurate and timely performance measurement will support the characteristics "alignment and synchronisation of SC and sustainability initiatives and goals" as well as "true cost allocation". Hence, this logic implies that the development of SSCM characteristics necessitates performing certain activities which, in turn, require respective enabling factors and the absence or appropriate managerial control of disablers.

## 3.5 Illustration of the SSCM Models

In order to demonstrate the applicability and usefulness of the SSCM transformation and maturity models, this section firstly introduces the concept of SSCM progression. This is followed by a well-publicised case scenario of the Mattel SC that illustrates how the models may be utilised.

### *3.5.1 SSCM Progression*

As evident from the review of the literature, process transformation and maturity development are tightly linked concepts. Based on this realisation, the stepwise SSCM transformation approach can be integrated with the dynamics in sustainable SCs put forward by the SSCM maturity model.

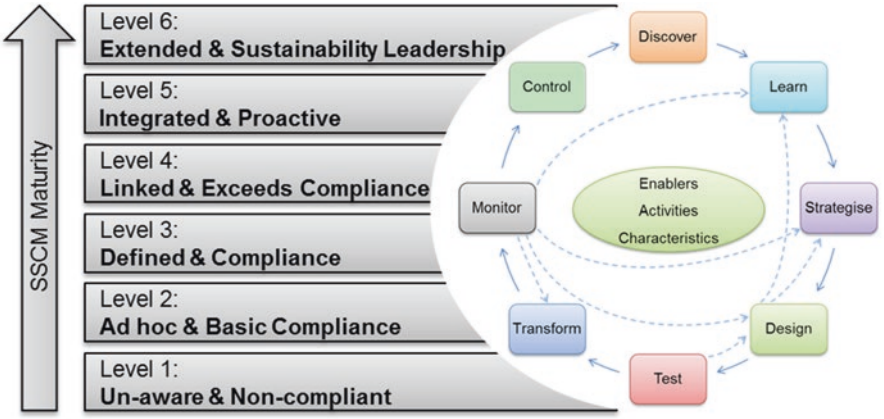


**Fig. 3.3** SSCM maturity progression

As shown in Fig. 3.3, this maturity progression proposes a cyclical multi-step approach, commonly used for transformation methodologies (Scheer et al. 2003; The Natural Step 2009) as well as iterative, convergent and linked decision-making processes (Simon 1977; Mintzberg et al. 1976; Langley et al. 1995). The progression between the levels of SSCM maturity is supported through an iterative transformation process consisting of defined phases which can be performed on a continuous basis. The time dimension is addressed specifically by outlining the strategic progression between the current state of a SC, its long-term vision, and transitional states of development. This approach follows the recommendations of seminal work in the field and addresses the need for a virtuous SSCM improvement methodology that is grounded in a deeper understanding of relationships and interactions in SSCM (Ashby et al. 2012).

The SSCM factors, i.e. enablers, disablers, activities, and characteristics, constitute essential building blocks for SCs aiming to become more sustainable. The categorisation of these factors into distinct but interconnected categories and their respective evaluations guided the design of the SSCM transformation and maturity models. These research artefacts may address the uncertainties and fill in the unknowns that decision makers tasked with SSCM are confronted with. The presentation of higher-level relationships allows for an easier grasp of their applicability and implications by providing a context and by illustrating the causal relationships between the factor groups. It needs to be acknowledged that empirical data can be interpreted in multiple ways (Ketokivi and Mantere 2010). Hence, other categorisations of the factors may also be coherent. Despite this potential shortcoming, SC scholars can use the SSCM factors and decision models in order to develop a better theoretical understanding of the logical relationships present in sustainable SCs. Furthermore, the SSCM models provide ample scope for related research endeavours, for example testing the relationships put forward empirically through case studies or survey instruments. Particular importance may be allocated to testing the

presence/strengths of specific factors (or groupings of factors) in (un)successful SSCM projects. Based on the research insights, SC practitioners can utilise the adaptable nature of the decision models alongside the importance evaluations of the factors. SSCM developments can be customised according to unique SC requirements and the different developmental stages, that is, levels of maturity. In summary, the research artefacts presented can benefit SC stakeholders by allowing them to assess, implement, transform, continuously develop and advance SC sustainability.

### *3.5.2 Case Illustration*

In this section, the models and their details presented are utilised for analysing the Mattel SC (as described in e.g. Gilbert and Wisner 2010; Hoyt et al. 2008; Schmidt 2008).

Mattel is an American multinational company that designs, manufactures, and markets toys worldwide. It had to recall millions of toys due to two keys problems (a) they contained magnets which came loose and were swallowed by children and (b) they were coated with paints that contained lead leading to poisoning (Gilbert and Wisner 2010). At the heart of this recall was a supply chain that was not sustainable in many different dimensions. At least seven of the SSCM disablers identified in Reefke and Sundaram (2018) were apparent in this SC:

(a) "focus on short term financial results"—CEOs often focus on short term results to keep shareholders happy. But organisations and CEOs will need to orient to a longer-term view of performance and health for the survival of their organisations and supply chains. This could often lead to short-term pain.
(b) "price war battles"—this is yet another area where organisations and supply chains fail by competing purely on price at the expense of quality. Here again such price wars may be used to increase revenue in the short term or could be used in the longer term to gain customers.
(c) "competition forces cost reductions"—high competition often leads organisations and SCs to try to reduce costs. This often leads organisation such as Mattel to shift their manufacturing to low labour cost countries.
(d) "collaboration"—many organisations like Mattel shift their manufacturing to low labour cost countries which are different linguistically, legally, socially, as well as culturally. This often leads to a lack of collaboration or an impedance mismatch in collaboration further leading to misunderstanding particularly around requirements, governance and compliance. This problem is even more accentuated the further we move along the tiers to second and third tier suppliers.
(e) The above decisions also lead to "long distances to import/export goods" which in turn lead to low visibility in the SC. The lack of visibility could be due to the reasons mentioned above in (d) as well as due to different information systems or even a lack of robust/formal systems further up the supply chain.

(f) One of the problems of long distances is "unverified claims of sustainable practices" of suppliers. And the flip side is also lack of visibility into unsustainable practices of suppliers and along the supply chain as a whole.
(g) Furthermore, the long distances usually result in a "dependence on fossil energy" for transportation. This dependence also extends to manufacturing.

In contrast more than seven of the SSCM Enablers (Reefke and Sundaram 2018) need to be strengthened or enhanced in the context of Mattel in order to improve the sustainability of their SC (Hoyt et al. 2008). Chief among these are:

(a) "sustainable material inputs"—this was one of the key problems with Mattel. The paint was contaminated with lead. Quality control measures need to be undertaken and strengthened both at the supplier end as well as inward goods of Mattel.
(b) "collaboration with suppliers"—collaboration with suppliers or lack thereof was at the root of the disaster. It is vital to improve visibility up and down the supply chain. Distances, time zone, language, and cultural differences, exacerbates problems of collaboration. There is a vital need to formalise collaboration through sound processes underpinned by groupware, workflow, and knowledge management systems.
(c) "performance measurement" of various vital KPI's related to quality, research and development, and production need to be instituted, monitored, benchmarked, and controlled. Tight quality control procedures in the supply chain including certification of suppliers, testing of raw materials, work-in-process, and final products.
(d) They also need a "realization of benefits through sustainability efforts", "awareness and acceptance of necessary time and cost investments", and "documentation of the impacts of SC". In Mattel's case it was literally "adapt or die". They had to invest time and money into sustainability efforts in order to survive. In fact, they created the post of senior vice president of corporate social responsibility to address the fallout.
(e) There is an apparent need for application of "models, frameworks, roadmaps to support the transformation towards SSCM".
(f) Furthermore an "efficient information/communication technology to increase sharing and updates" would have allowed Mattel to be aware of the problem early on and address it in a proactive manner rather than reactively. As mentioned earlier cross-national inter-organisational knowledge, workflow, and knowledge management system are vital for sustainable supply chains.

Ameliorating the disablers and enhancing the enablers identified and introducing key SSCM support activities would have enabled Mattel to progress on their sustainability journey. Almost every one of the activities identified in Reefke and Sundaram (2018) is relevant for Mattel, even extending towards "reverse logistics" considering the product recall. These activities would help the Mattel SC to develop the identified SSCM characteristics. And as these characteristics develop the hope is that the "un-aware and non-compliant" parts of the Mattel SC would be able to

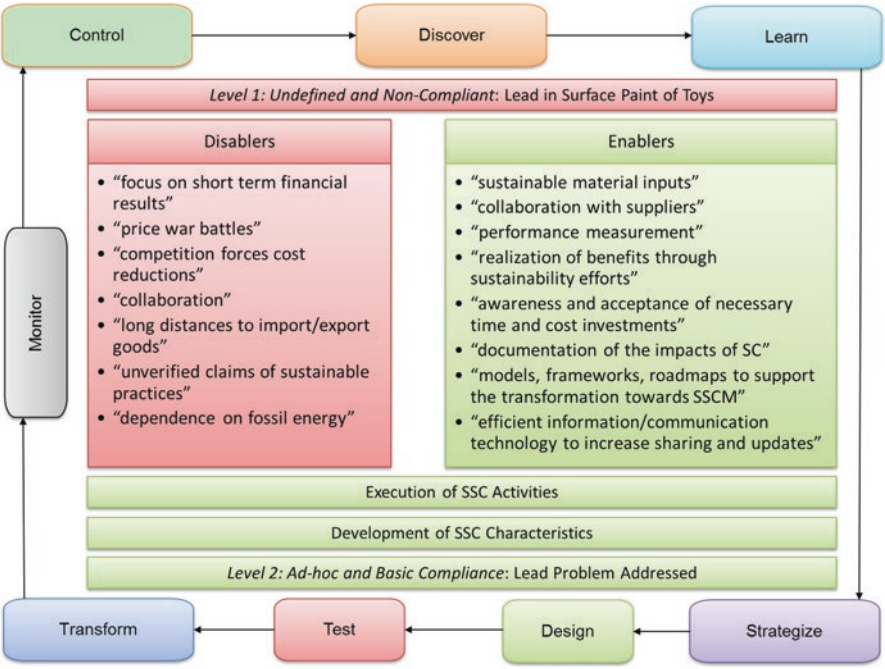


**Fig. 3.4** Maturity progression illustration (adapted from Reefke and Sundaram 2018)

move towards higher maturity levels and potentially (if desired) to "extended and sustainability leadership" (Fig. 3.2).

The disablers, enablers, activities and characteristics are intertwined and have causal relationships. But how does a SC go about ameliorating the disablers, enhancing the enablers, and executing the activities? It is in this context that the SSCM transformation model illustrated in Fig. 3.1 and its detailed elements come to the fore. Applying this model systematically over a period of time could enable the SC to mature in terms of sustainability (Fig. 3.2). The connection between the two models is shown in Fig. 3.3 and further illustrated through the Mattel case in Fig. 3.4.

## 3.6 Conclusion

This chapter aims to illuminate the multiple facets of practices that can support or hinder SSCM, thereby providing a more solid theoretical foundation of SSCM relationships for scholars in the field. Targeting the objectives outlined in the introduction, definitional constructs of SSCM and building blocks of sustainable SCs were deconstructed and explored. Further, decision-making processes for the

transformation of SCs towards sustainability and their ongoing development were translated into targeted decision support models.

This chapter thus offers several insights and guiding material: As a foundation, opportunities for enquiries in SSCM relating to decision support are synthesised from seminal journal articles in the field and organised into the overview presented in Table 3.2. Academic scholars can use the outlined research requirements with regard to decision support in SSCM in order to inform and adapt their research priorities and resulting agendas. In response to these research and practical requirements in SSCM, two problematic decision areas are explored in detail: (1) The transformation SCs and their various operations across the SC members towards sustainability and (2) the development of SSCM maturity guided by a prescriptive and structured approach. Insights into the dependencies between factors and their influence on the success of SSCM are provided. The concept of SSCM maturity progression connects the two models and their elements, illustrating how they may be utilised in combination. Discussions illustrate how the overall study findings complement and extend existing approaches in the field while a case scenario illustrates their practical application. This chapter thus provides a targeted overview of decision support artefacts that can be used in a prescriptive manner in order to inform the practical application of SSCM. In combination these are useful as building blocks for a customised SSCM strategy and can guide SC managers in the prioritisation of activities and prerequisites for SSCM. Further, the overviews of definitions and research requirements coupled with the decision models inform and guide scholars in the field in structuring and targeting future research avenues.

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